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USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK

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F-16A In-Flight Crew Noise,

10 Harold K. Hille

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FOR THE COMMANDER



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The F-16A is a USAF lightweight fighter. This report provides measured data defining the bioacoustic environments at the pilot's location inside this aircraft for 16 flight conditions. Data are reported for one location in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived noise level, and limiting times for		

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total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application," AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

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Preface

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 723108, Crew Safety In Operational Noise Environments.

The author acknowledges the efforts of John N. Cole, who established the data analysis requirements and assisted in the preparation of this report, and Henry Mohlman and David Eilerman of the University of Dayton, who assisted in the mechanics of data processing.

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INTRODUCTION

The F-16A is a USAF lightweight fighter manufactured by the General Dynamics Company, Fort Worth, Texas. Power is provided by one F100-PW-100(2) turbofan engine manufactured by the United Aircraft Corporation, Pratt & Whitney Aircraft Division.

This volume provides measured data defining the bioacoustic environments produced inside the aircraft. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the F-16A aircraft.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during *ground operations* of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. Refer to Volume 1 (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., in-flight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of the updated index as it is generated.

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1. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application*, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

IN-FLIGHT NOISE

MEASUREMENTS

All noise measurements were made on-board a F-16A aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard F-16A environments but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Acoustic measurements were made inside the cockpit at the pilot's location. Table 1 lists the measurement location and test conditions as numeric/alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A, etc.

The microphone was attached to the pilot's helmet by means of a lightweight boom. This arrangement enabled adjustment of the microphone close to the ear level at a distance of 0.1 meter with its diaphragm parallel and facing away from the helmet's surface. In the analysis, microphone corrections for random incidence were applied to the overall systems response. The recorded samples were analyzed using a four or eight second integration time to obtain a power-averaged level which effectively smooths out short duration fluctuations and best describes the exposure.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the F-16A aircraft at the specified location. This table includes the overall, 1/3 octave band, and octave band levels. From these data, C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These measures are widely used to assess the effects of noise on personnel and their performance.

TABLE 1

MEASUREMENT LOCATIONS AND TEST CONDITIONS
F-16A, Edwards AFB, 27 May 1977
Serial #75-0745

<i>Location</i>	<i>Position</i>	<i>Flight Above Deck</i>
I	Cockpit	Seated Head Level
<i>Condition</i>	<i>Description</i>	
A	Idle Power, Canopy Closed, Air Source — NORM, Temp — AUTO (mid), Defog — DECR	
B	Mil Power Takeoff, Air Source — NORM, Temp — AUTO (mid), Defog — DECR	
C	Mil Power, Climb to 5000 Ft, Air Source — NORM, Temp — AUTO (mid), Defog — DECR	
D	Mil Power, Climb from 15000 Ft to 30000 Ft, Speed 410 KIAS, .8 M, —304 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid), Defog — FWD	
E	Cruise at 25000 Ft, Speed 338 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid), Defog — FWD	
F	Cruise at 20000 Ft, Speed 373 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid) and Defog — FWD	
G	Cruise at 20000 Ft, Speed 373 KIAS, .8 M, Air Source — NORM, Temp — MAN, Defog — FWD	
H	Cruise at 20000 Ft, Speed 373 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid) and Defog — MAX	
I	Cruise at 20000 Ft, Speed 373 KIAS, .8 M, Air Source — OFF	
J	Normal Descent from 20000 Ft to 5000 Ft, Idle, S/B Out, Air Source — NORM, Temp — AUTO (mid), Defog — FWD	
K	Cruise at 5000 Ft, Speed 488 KIAS, .8 M, Air Source — NORM, Temp — AUTO (mid), Defog — FWD	
L	Cruise at 5000 Ft, Speed 488 KIAS, .8 M, Air Source — NORM, Temp — MAN, Defog — FWD	
M	Cruise at 5000 Ft, Speed 488 KIAS, .8 M, Air source — NORM, Temp — AUTO (mid), Defog — MAX	
N	Cruise at 5000 Ft, Speed 488 KIAS, .8 M, Air Source — OFF	
P	High Speed Run at 10000 Ft, Speed from 448 KIAS, .8 M to 637 KIAS, 1.12 M, Air Source — NORM, Temp — AUTO (mid), Defog — OFF	
Q	Landing and Roll, Air Source — NORM, Temp — AUTO (mid), Defog — FWD	

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)

2

1/3 OCTAVE BAND

F-16A AIRCRAFT
INFLIGHT NOISE LEVELS

NOISE SOURCE/SUBJECT: OPERATION!

F-16A AIRCRAFT

INFLIGHT NOISE LEVELS

NOISE SOURCE/SUBJECT: OPERATION!

F-16A AIRCRAFT

INFLIGHT NOISE LEVELS

TEST 77-009-001

RUN 01

PAGE F1

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PAGE F1

FREQ (HZ) 1/A 1/B 1/C 1/D 1/E 1/F 1/G 1/H 1/I

31.5	77	84	84	70	69	71	83	74	57
40	80	88	83	72	71	72	80	73	56
50	80	95	81	69	69	75	73	62	
63	81	85	87	80	80	81	84	77	69
80	81	84	85	78	78	81	85	75	66
100	83	87	89	84	85	85	86	80	73
125	87	89	91	86	87	86	87	86	80
160	82	86	89	84	86	83	86	86	84
200	91	90	95	91	91	93	91	85	77
250	92	93	97	94	93	95	96	90	86
315	89	89	93	89	91	91	93	89	83
400	93	93	99	92	93	93	97	97	95
500	91	95	94	92	93	94	96	96	92
630	92	95	96	93	93	94	99	99	84
800	92	93	96	94	91	94	96	92	84
1000	91	92	94	91	91	92	96	90	79
1250	92	91	96	93	92	93	108	92	78
1600	85	88	90	87	88	88	97	93	75
2000	79	83	86	83	84	85	94	93	
2500	83	88	88	81	80	79	90	95	72
3150	81	76	79	76	79	77	86	98	71
4000	75	72	76	78	78	76	84	99	69
5600	76	71	78	77	78	76	85	101	70
6300	73	68	74	76	76	79	95	70	
8000	73	67	76	80	80	79	81	98	74
10000	68	67	76	83	82	81	84	98	74
12500	64	64	75	82	82	83	89	98	75
OVERALL	102	103	106	102	102	103	108	108	93

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)

2

1/3 OCTAVE BAND

NOISE SOURCE/SUBJECT: F-16A AIRCRAFT
INFLIGHT NOISE LEVELS

FREQ (HZ)	OPERATION:						PAGE F2
	1/J	1/K	1/L	1/M	1/N	1/P	
31.5	74	82	85	85	81	75	81
40	75	80	85	83	82	75	82
50	77	80	84	84	80	74	79
63	85	87	90	86	83	85	86
80	81	88	90	85	84	85	84
100	89	91	93	88	88	88	88
125	98	95	97	91	95	91	88
160	66	95	98	93	98	92	85
200	92	99	98	92	94	96	93
250	95	100	103	97	101	99	95
315	92	97	98	110	97	97	90
400	96	102	101	96	98	99	94
500	93	102	101	96	98	92	92
630	94	101	103	98	98	99	92
800	91	101	104	99	97	100	92
1000	99	99	103	99	96	99	91
1250	96	104	104	101	93	98	91
1600	96	97	103	102	93	96	88
2000	89	97	99	101	94	93	82
2500	76	89	95	102	87	91	77
3150	76	87	90	105	87	91	75
4000	74	86	88	106	85	91	72
5000	74	87	89	106	86	91	81
6300	75	86	86	111	84	89	71
8000	79	85	85	108	84	89	66
10000	80	86	86	109	85	86	65
12500	81	86	86	109	85	86	65
OVERALL	103	111	113	116	108	109	103

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE I MEASURED SOUND PRESSURE LEVEL (DB)
OCTAVE BAND
2

NOISE SOURCE/SUBJECT: F-16A AIRCRAFT INFLIGHT NOISE LEVELS	OPERATION:	IDENTIFICATION:							
		TEST 77-009-001	RUN 01	27 SEP 76	PAGE J1				
FREQ (HZ)	1/A	1/B	1/C	1/D	1/E	1/F	1/G	1/H	1/I
31.5	82	89	86	74	73	74	84	77	61
63	85	90	90	82	82	84	88	80	72
125	89	92	94	89	91	90	93	89	86
250	95	96	100	97	96	96	98	93	88
500	97	99	101	97	98	98	103	93	88
1000	96	97	100	97	96	96	103	96	86
2000	87	89	92	89	90	90	99	96	79
4000	83	78	83	62	63	61	90	104	74
8000	76	72	80	65	65	64	86	103	78
OVERALL	102	103	106	102	103	108	108	108	93

TABLE: MEASURED SOUND PRESSURE LEVEL (dB)

2 OCTAVE BAND

FREQ (HZ)	1/J	1/K	1/L	1/M	1/N	1/P	1/Q
31.5	77	84	89	87	64	78	84
63	97	91	93	90	87	88	89
125	93	99	101	96	100	96	92
250	98	103	105	110	103	102	98
500	99	107	107	101	103	103	98
1000	95	104	108	104	100	104	95
2000	87	99	105	106	96	99	89
4000	79	92	94	111	90	96	82
8000	63	90	96	114	89	93	73
OVERALL	10.3	11.0	11.3	11.8	10.6	10.9	10.3

IDENTIFICATIONS

OMEGA 3.2
TEST 77-009-001
RUN 02
27 SEP 76
PAGE J2

TABLE: MEASURES OF HUMAN NOISE EXPOSURE

3

NOISE SOURCE/SUBJECT: OPERATION:

F-16A AIRCRAFT
INFLIGHT NOISE LEVELS

1/A 1/B 1/C 1/D 1/E 1/F 1/G 1/H 1/I

HAZARD/PROTECTION
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DB) AT EAR
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)

NO PROTECTION	OASLC	102	103	106	102	102	103	108	107	93
OASLA	T	99	100	103	100	100	101	106	108	90
HGU-2A/P HELMET WITH H-154	OASLA*	36	30	16	36	70	25	11	8	170
HGU-2A/P HELMET WITH H-154 (A)	OASLA*	240	202	181	202	202	170	101	71	907
HGU-2A/P HELMET WITH CUSTOM LINER	OASLA*	84	85	89	85	85	86	89	83	77
HGU-2A/P HELMET WITH CUSTOM LINER	OASLA*	480	404	202	404	404	339	202	571	960
	T	71	50	36	60	60	50	21	85	339

COMMUNICATION	PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)	PSIL
	93 95 96 94 94 95 102 96 84	

ANNOYANCE
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)
TONE CORRECTION (C IN DB)

PNLT	C	111	111	115	112	111	112	116	123	103
		1	1	1	1	0	1	1	1	1

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE I MEASURES OF HUMAN NOISE EXPOSURE

- + BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.